SECTION III.—FORECASTS.

FORECASTS AND WARNINGS FOR DECEMBER, 1915.

By EDWARD H. BOWIE, District Forecaster.

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December, 1915, was characterized by (1) a great diversity in the intensity of and the paths followed by the centers of low pressure during their passage across the United States, and (2) by a preponderance of areas of high pressure from the Pacific coast rather than from Canada. The cause of the wide variations in the paths of centers of low pressure may be attributed to the pronounced fluctuations in the Aleutian subpermanent area of low pressure, of which nearly all storms that first appear in the Northwest at this season of the year are offshoots, or secondaries. The telegraphic reports from Alaska show that the Aleutian low-pressure area was well organized during two short periods, namely, 1st to 6th and 16th to 22d. At other times during December, 1915, this low area was not well defined and pressures at the several Alaskan stations averaged relatively high. With regard to the predominance of highs from the Pacific Ocean instead of Alaska, the inference is based on the cabled reports from Honolulu and the south coast of Alaska that the permanent high off the California coast was of large area and the pressures within were above normal and that the highs that enter the United States from the Pacific Ocean were but offshoots from it. Moreover, it was not until the last week in December that areas of high barometer entered the United States from Canada, and then when the reports from Honolulu showed that the high-pressure area off the California coast had presumably lost intensity and become ill defined. Another peculiarity of the month was the unusual number of secondary disturbances that accompanied Northwest lows. The first of these formed over Nevada on the 4th and passed thence to Texas on the 6th, whence it was prevented from following a usual northeast course by an area of high barometer of great magnitude that had its center over the Great Lakes from the 3d to the 6th. An Alberta storm made its appearance on the 5th and traveled eastward along the northern border during the 6th, 7th, 8th, and 9th, and on the 8th it developed a secondary center of low pressure off the New Jersey coast. Again, the Alberta low (IV on Chart III) which first made its appearance over British Columbia on the 8th, reached the Ohio Valley on the 11th, and on that date a secondary storm center developed off the Carolina coast, and moving northward became a disturbance of great intensity in New England on the 13th. Similarly, low V which made its appearance in Alberta on the 13th, developed a secondary over eastern Tennessee on the 17th, which moved rapidly northeastward and gained great intensity on the 18th when passing over New England. Moreover, low VII, a northern Rocky Mountain storm, which first made its appearance on the 23d, on reaching the lower Lake region, developed a secondary center over Virginia on the 25th, and this gained intensity and moved northeast along the coast, attended by rains, sleet, snow, and shifting gales. It will be noted that all these secondary centers attended Northwest lows. As a matter of fact, these lows—the Alberta, north Pacific, and northern Rocky Mountain—are most prolific of secondary storm formations and must be carefully watched by the forecaster, as stated in MONTHLY WEATHER REVIEW, Supplement No. 1, July, 1914.

As might be expected, the majority of the high areas being of Pacific origin, few of these were attended by unusually low temperatures. In fact, the only extremely low temperatures during the month occurred during its last decade and these in connection with highs that entered the United States from Canada.

Great Lakes.—On the Great Lakes the season for the display of storm warnings ended on December 20, and press and other reports are to the effect that the 1915 season of navigation was one of small marine loss of life and property. The necessity for giving all possible information to shipping on the Great Lakes during the remaining days of the season of navigation, when winds and weather are most dangerous to navigation, was recognized and advance information was sent when conditions demanded. Thus on Thursday, the 2d, the following advisory information was sent Lake stations:

> Winds of moderate force, mostly west to south, and generally fair weather with normal temperatures probable on Great Lakes during the remainder of this week. Disturbance now approaching the north Pacific coast will reach the Great Lakes Sunday or Monday and be attended by high winds and rain and snow. Distribute this information to shipping.

The storm referred to reached the Lakes at the beginning of the following week, and on the 7th storm warnings were ordered for the Great Lakes, except extreme southern Michigan, and strong winds and snows and rains occurred as forecast. On Thursday, the 9th, the following advisory information was sent stations on the Great Lakes:

> Storm forming over eastern Colorado and it will in all probability move toward the Great Lakes and cause snow and strong winds by Friday night and on Saturday. Advise shipping to exercise caution.

Storm warnings were displayed on the 10th on Lake Michigan. The storm in question moved due east instead of northeast and dissipated on the afternoon of the 11th on reaching the middle Mississippi Valley. Storm warnings were again ordered for Lake Michigan on the 15th and for Lakes Superior, Huron, and Erie on the 16th, in advance of a storm that moved from Texas northeastward over the middle Mississippi Valley and thence to lower Michigan. Strong winds with snow and rain occurred on all lakes where warnings were displayed. The highest velocity reported was 52 miles per hour from the southeast during the night of the 16th, at Erie, Pa.

Atlantic coast.—On the 8th storm warnings were ordered on the coast from Delaware Breakwater to Eastport, in connection with a storm that was moving eastward from the Great Lakes, and on the 9th storm winds occurred as follows:

> Delaware Breakwater, 44 miles per hour from northwest; New York, 48 miles per hour from northwest; Sandy Hook, 52 miles per hour from northwest; Block Island, 48 miles per hour from northwest.

On the 11th storm warnings were ordered from Savannah to Boston, as there were evidences of a disturbance forming off the South Atlantic coast. Strong winds

occurred along the coast south of the mouth of the Delaware on the 12th, when the disturbance was off Cape Hatteras. On the morning of the 13th this storm gave evidence of changing its course to northerly and northeast storm warnings were ordered displayed from Sandy Hook to Eastport. Special observations at noon on this day gave conclusive indications that the storm would greatly increase in intensity, and the following advisory warning was sent New England and Middle Atlantic coast stations:

Storm off New Jersey coast, increasing in intensity and moving northeast. Strong shifting gales indicated for the Atlantic coast from Sandy Hook north to Eastport this afternoon and to-night. Advise all shipping.

This storm became one of the severest storms of the year on the Middle Atlantic and New England coasts, and it was attended by heavy sleet and snows in New England and New York. Winds of force 9 to 11 occurred along the New England and New Jersey coasts, and the pressure fell to below 29 inches on the New England coast. The warnings, however, were timely and no considerable amount of shipping was lost. A number of barges and small boats were driven ashore in the harbors of New York and New England. Storm warnings were again displayed on the 17th from Boston to Jacksonville and on the morning of the 18th the display was extended to Eastport. Storm winds occurred on the 18th over the entire area covered by the warnings. The highest winds reported on this date were as follows:

Jacksonville, 48 miles per hour from southeast; Charleston, 48 miles per hour from south; Hatteras, 52 miles per hour from southwest; Norfolk, 52 miles per hour from southwest; Delaware Breakwater, 72 miles per hour from northwest; New York, 64 miles per hour from northwest; and Block Island, 48 miles per hour from northwest.

On the 23d warnings were ordered displayed from Delaware Breakwater to Eastport, as a storm of considerable intensity was then moving eastward from the Great Lakes, but this storm lost intensity on reaching the St. Lawrence Valley and the winds sufficient to justify warnings did not materialize.

On the 24th, however, another storm moved rapidly eastward from the Rocky Mountain region until at 8 p. m. of that date its center was over the middle Mississippi Valley. Warnings were ordered, therefore, on the Atlantic coast from Jacksonville, Fla., to Boston, Mass., and on the morning of the 25th the display was extended northward to Eastport. During the 25th this storm moved rapidly eastward, and the evening of that date its center was over the Middle Atlantic States, whence it moved rapidly northeastward. On the morning of the 26th the lowest pressure was 28.90 inches, at Hartford, Conn. Storm winds occurred over the entire areas covered by warnings, the highest velocities being:

Jacksonville, 72 miles per hour from southwest; Norfolk, 60 miles per hour from west; Delaware Breakwater, 68 miles per hour from west; New York, 88 miles per hour from northwest; Block Island, 84 miles per hour from west; Nantucket, 72 miles per hour from southwest; Boston, 48 miles per hour from northwest; Portland, 52 miles per hour from west; and Eastport, 48 miles per hour from southeast.

Reports indicate that shipping was fully warned and little loss resulted from the severe storm winds.

On the morning of the 28th a storm was charted over Louisiana and at 8 p. m. of that date its center was over Mississippi and moving northeast. Storm warnings were then displayed on the Atlantic coast from Jacksonville, Fla., to Portland, Me., and the morning of the 29th the display was extended to Eastport. This storm advanced rapidly northeastward; it caused heavy snows and sleet in the Ohio Valley and the southern portion of the region of the Great Lakes, the interior of New York, and New England, and winds of gale force along the Atlantic coast from Savannah to Eastport. The highest velocities reported were:

Pensacola, 72 miles per hour from southwest; Savannah, 34 miles per hour from south; Charleston, 36 miles per hour from south; Hatteras, 42 miles per hour from southwest; Norfolk, 52 miles per hour from southwest; Sandy Hook, 60 miles per hour from northeast; Block Island, 60 miles per hour from northeast; Nantucket, 52 miles per hour from northeast; and Boston, 38 miles per hour from northeast.

East gulf coast.—Storm warnings were ordered on the morning of the 17th from Bay St. Louis, Miss., to Cedar Keys, Fla., the information being to the effect that strong shifting winds would become northwest the following night. At the time the warning was issued a storm of considerable intensity was over the lower Mississippi Valley. The highest velocity reported in the region where storm warnings were displayed was 48 miles per hour from the southwest at Pensacola the afternoon of the 17th. On the 20th the following advisory warning was sent east gulf and south Atlantic ports:

There are some indications of a disturbance over the east Gulf of Mexico.

This disturbance crossed extreme southern Florida during the evening of the 20th and it caused a northwest gale of 52 miles an hour at Key West and of 30 miles an hour at Tampa. The official in charge at Pensacola, under date of January 3, 1916, forwards the following extract from the log of the fishing schooner *Ida S. Brooks*, Capt. Frank Cooney, jr., concerning the storm:

Left Pensacola on December 18, 1915, bound for Campeche Banks, wind north, light all day Sunday, 19th; wind northeast blowing. Took in mainsail at 3 o'clock. At 8 o'clock took in both jibs, blowing gale from northeast.

Monday 20th: 6 a. m., running under foresail; strong breeze. At 8 a. m. the wind went around to southwest and died out. Calm for about 20 minutes, then hit from about west-southwest. Took in foresail which vessel could not carry. We were then in about latitude 25° 50′ N., longitude 87° 00′ W. At 9 a. m. the barometer read 29.25″ and the vessel went on her beam ends. It was blowing so hard that nobody could stand on deck. Vessel going lower all the time. Went so low that she lost her bearings and could not come back. She was so full of water that she began filling through after companionway. Stern all under water. Cut lanyards from outside on main rigging and the wind took both spars and bowsprit. After getting clear of spars and rigging put out drag so as to hold vessel up to wind. The wind hauled to northwest and blew hard all day. The vessel drifting about south with ensign union down.

Tuesday, 21st: Kept good lookout. The wind went north-northwest. Weather fine. We had only our jumbo boom on which we have our ensign. At noon, latitude 25° 42′, Pensacola bears by D. R. [dead reckoning] north, distance 278 miles.

Thursday, 23d: Spoke S. S. *De Larrinaga* 11:30 p. m.; Capt. H. C. Kramer reported us by wireless. The captain offered tow to Galveston; thanked him and told him I thought I could get vessel to port. Latitude 25° 54′, longitude 86° 09′.

Saturday, 25th: 6 a. m., rain squall struck us. 8 a. m., wind west; heading north by west making about 2 miles per hour under jury rig. 9 a. m., whirlwind and water spouts all around us, wind struck from northwest, vessel heading northeast by east.

Friday, December 31: Arrived at sea buoy Pensacola 8 a. m., wind east, strong breeze.

(Signed) FRANK COONEY, Jr.,
Captain Schooner "Ida S. Brooks."

Storm warnings were again displayed on the 24th on the coast from Bay St. Louis, Miss., to Tampa, when a storm of considerable intensity was over the middle Mississippi Valley. This storm passed without causing winds of more than 30 miles an hour in this region. On the morning of the 28th northwest storm warnings were displayed from Bay St. Louis to Apalachicola, the storm at this time being over Louisiana. This disturbance advanced eastward, increased greatly in intensity, and caused gales on the coast where warnings were displayed. The highest velocity reached was 72 miles an hour from southwest during the night of the 28th at Pensacola.

COLD WAVE AND FROST WARNINGS.

Warnings of frosts were issued on a number of dates for the south Atlantic and Gulf States and the Florida Peninsula. The most important of these were in connection with frosts in Florida on the 14th, 15th, 21st, 23d, and 26th.

Cold-wave warnings were issued on the 16th for western Tennessee, Alabama, Mississippi, and northwest Florida; on the 24th for Tennessee, Mississippi, Alabama, Georgia, and extreme northwest Florida; and on the 27th for western Tennessee and Mississippi. Decided falls in temperature occurred in all instances, but no abnormally low temperatures were recorded.

Heavy-snow warnings were issued on the 24th for northern Indiana, northern Ohio, and extreme southern Michigan, and on the 26th heavy-snow warnings for the interior of northern New England were ordered. These warnings were verified in all instances.

DISTRICT WARNINGS DURING DECEMBER.

Chicago forecast district.—No warnings of any kind were required until the 24th, when warnings of moderately heavy snow were issued for northern Illinois and the vicinity of St. Louis, Mo. The warnings were verified. On the evening of the 27th warnings of heavy snow were issued for southeastern Missouri and southern Illinois and again for southeastern Illinois on the evening of the 28th. These warnings were not verified. There was heavy precipitation in southeastern Illinois during the night of the 28th–29th in the form of rain and sleet, although the temperature was freezing or below.

On the evening of the 25th a disturbance of considerable force was centered over North Dakota, whence it moved directly eastward across the Lake region and was followed by a decided increase in pressure throughout the Northwest. Cold-wave warnings were issued for the entire Northwest, except western Montana, and the Plains States either the evening of the 25th or the morning of the 26th. These warnings were fully verified in northwestern Wisconsin, Minnesota, and North Dakota, and partly verified in the other States. Warnings were again issued for North Dakota, eastern Montana, and northern Wyoming on the morning of the 28th, and for the remainder of the Northwest including western Nebraska and Minnesota, on the evening of the 28th and the morning of the 29th. These warnings were only partially verified, the cold wave not advancing east of the 100th Meridian on account of the fact that the low pressure area which was over the southeastern slope (29.40″ at| Amarillo, Tex.) on the morning of the 29th, failed to advance, filling up instead.—*Charles L. Mitchell, Assistant Forecaster.*

Portland, Oreg., Forecast District.—During December important storm warnings were issued on six separate occasions, viz, on the 4th, 5th, 7th, 19th, 20th, and 27th. Several other warnings were issued which were fully verified.—*T. F. Drake, Assistant Forecaster.*

San Francisco Forecast District.—A moderate storm moved in from the ocean on the 2d, and gave precipitation over the entire district with strong southerly winds on the north coast. Another storm covering the period 11th–14th, gave precipitation over the northern portion of the district with strong southerly winds on the central coast. The reports received from incoming vessels indicated much higher winds at sea than the coast stations showed.

An area of high pressure moved southward over British Columbia at the close of the month and gave damaging frosts in northern California and rain and snow in southern California. The conditions were forecast successfully in all cases.—*G. H. Willson, District Forecaster.*

Denver Forecast District.—The cold-wave warnings issued for western Utah on the 15th were not fully verified, although an anticyclonic area occupied the Great Basin on the following morning and a temperature of 12° F. was reached at Modena. On the morning of the 26th an extensive, cold, high-pressure area was spreading rapidly eastward across Montana and Wyoming and southward over the Plateau region. Cold-wave warnings were issued for central and southwestern Colorado and central Arizona. These warnings were fully verified in central Colorado and a sharp fall in temperature occurred in central Arizona. On the evening of the 26th the temperature at Roswell, N. Mex., was 60°, and a cold-wave warning was issued for southeastern New Mexico. The warning was followed by a 24-hour fall in temperature of 40 degrees over the southeastern portion of the State. On the morning of the 29th a cold anticyclonic area was advancing southward over Montana, and cold-wave warnings were issued for eastern Colorado. This warning was fully justified in northeastern Colorado where zero temperatures occurred; the cold wave did not reach southeastern Colorado, however, as the southwestern storm on that date caused a continuance of southerly winds in that part of the State. The cold-wave warning issued for north-central Arizona on the 30th was a failure, as the storm remained stationary in northern Arizona, prolonging the cloudy weather.—*Frederick W. Brist Assistant Forecaster.*

New Orleans Forecast District.—Cold-wave warnings were issued on the 15th, 16th, 24th, and 27th.

The cold wave on the 17th gave a fall in temperature of 20 to 30 degrees over Oklahoma, Arkansas, eastern Texas, and northern Louisiana, but the verifying temperature was recorded at only a few stations.

The cold wave on the 25th gave a fall in temperature of 20 to 30 degrees over Arkansas, Louisiana, and the northern portion of eastern Texas, freezing temperature over the interior of eastern Texas, and about 40° F. on the Gulf coast.

The cold wave on the 28th gave a fall in temperature of 20 to 30 degrees over Arkansas, eastern Texas, and northern Louisiana, with temperatures of 20° to 32° in Arkansas, 24° to 32° over the interior of eastern Texas, and 38° to 42° on the Texas coast.

Storm warnings were issued for the Louisiana and Texas coasts on the 24th and for the Texas coast on the 27th, and verifying winds occurred at some stations.—*I. M. Cline, District Forecaster.*